DTC P2205, P2209, P22A3, or P22A7

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P2205

NOx Sensor 1 Heater Control Circuit

DTC P2209

NOx Sensor 1 Heater Feedback Performance

DTC P22A3

NOx Sensor 2 Heater Control Circuit

DTC P22A7

NOx Sensor 2 Heater Feedback Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
NOx Sensor Ignition Voltage	U029D, U029E, P220A, P220B	U029D, U029E	U029D, U029E, P220A, P220B	—
High Speed GMLAN Serial Data (+)	U0074, P205D	U010E, P205D	U0074, P205D	—
High Speed GMLAN Serial Data (−)	U029D, U029E, U010E, P205D	U010E, P205D	U010E, P205D	—
NOx Sensor Ground	—	U029D, U029E	—	—

Circuit/System Description

The reductant system uses two nitrogen oxide (NOx) sensors to monitor the amount of NOx in the engine's exhaust gas. The first sensor is located at the outlet of the turbocharger and monitors the engine out NOx level. The second NOx sensor is located between the selective catalytic reduction (SCR) and the diesel particulate filter (DPF) and monitors NOx levels downstream of the

SCR. The second NOx sensor also provides the engine control module (ECM) with information on the exhaust oxygen level during DPF regeneration.

Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust.

The ECM varies the amount of diesel exhaust fluid (DEF) or reductant added by varying the reductant injector duty cycle in response to changes in engine exhaust out NOx levels.

The smart NOx sensors consist of two components, the NOx module and the NOx sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

The NOx sensors must be at operating temperature in order to function properly. The Glow Plug Control Module (GPCM) provides 12 V to the NOx sensors heaters to assist in reaching operating temperature.

Conditions for Running the DTCs

DTC P2205

- The battery voltage is greater than 11 V.
- The engine speed is greater than 600 RPM for greater than 10 s.
- The Exhaust Gas Temperature Sensor (EGT) 2 is greater than 95°C (203°F).
- The DTCs run continuously when the above conditions are met.

DTC P22A3

- The battery voltage is greater than 11 V.
- The engine speed is greater than 600 RPM for greater than 10 s.
- The EGT 4 is greater than 95°C (203°F).
- The DTCs run continuously when the above conditions are met.

DTC P2209

- DTC P064C, P163C, P220A, or P220B are not set.
- The battery voltage is greater than 11 V.
- The engine speed is greater than 600 RPM for more than 10 s.
- The EGT 2 is greater than 95°C (203°F).
- The DTCs run continuously when the above conditions are met.

DTC P22A7

- DTC P064C, P163C, P220A, or P220B are not set.
- The battery voltage is greater than 11 V.
- The engine speed is greater than 600 RPM for greater than 10 s.
- The EGT 4 is greater than 95°C (203°F).
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P2205 or P22A3

The ECM receives a NOx sensor module serial data message indicating an open or shorted heater control circuit for greater than 3 s.

DTC P2209 or P22A7

The ECM receives NOx sensor module serial data message indicating that the sensor is not ready or the sensor message is invalid for greater than 0.5 s.

Action Taken When the DTC Sets

- DTCs P2205, P2209, P22A3, and P22A7 are Type B DTCs.
- The ECM inhibits the reductant system and scan tool special functions until the DTC is cleared.
- The ECM commands the engine to operate in Reduced Engine Power mode.
- The driver information center may display the Engine Power Is Reduced message.

Conditions for Clearing the DTC

DTCs P2205, P2209, P22A3, and P22A7 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. DTC UXXXX should not be set.
   ⇒ If a DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
2. Verify the following conditions do not exist with the exhaust system:
   - Intake system leaks—Refer to Induction System Smoke Test and Full System Air Leak Test in Charge Air Cooler Diagnosis.
   - Exhaust leaks — Refer to Exhaust Leakage
   - Physical damage
   - Loose or missing hardware

- Loose B195 NOx sensors or B131 exhaust temperature sensors

⇒ If a condition is found, repair the exhaust system.

3. If the exhaust system tests normal, replace the B195 NOx sensor.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

- Nitrogen Oxide Sensor Replacement - Position 1
- Nitrogen Oxide Sensor Replacement - Position 2
- Perform the scan tool NOx Sensor 1 or 2 Reset procedure after replacing the NOx sensor 1 or 2.
- Perform the Diesel Particulate Filter (DPF) Regeneration Enable after replacing the NOx sensor 1

Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes.

   Warning: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.
5. In order to clear the DEF lamp, perform the Reductant Fluid Quality Test. The DEF lamp should turn OFF once the test is finished.

   ⇒ If the DEF lamp does not turn OFF, a condition with the system still exists.